Robert S. Mahurin, Ph.D.

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Educator, science communicator, and problem-solver.
I make complicated problems simple and make baffling situations understandable.

Employment history

2021–2022	**Data Scientist** Avrio Analytics, `https://avrio.ai` Part-time consultant on data-science projects for various clients
2014–2019	**Lecturer** (in 2019: as adjunct) Department of Physics and Astronomy Middle Tennessee State University Murfreesboro, Tennessee
2011, 2013	**Adjunct professor of astronomy and physics** Department of Physics, Computer Science, and Engineering Christopher Newport University Newport News, Virginia
2009–2013	**Postdoctoral researcher** University of Manitoba, Winnipeg Located at and partially funded by: Thomas Jefferson National Accelerator Laboratory, Newport News, Virginia
2002–2009	**Graduate research assistant** University of Tennessee, Knoxville
2001–2003	**Graduate teaching assistant** University of Tennessee, Knoxville

Education

2009	**Doctor of philosophy** University of Tennessee, Knoxville Major in physics Dissertation: "Parity violation in polarized cold neutron capture"
2001	**Bachelor of science,** ***summa cum laude*** University of Tennessee, Knoxville Major in physics; minors in astronomy and mathematics

Technical skills

- **Numerical and statistical analysis.** My current favorite data language is Python, and the toolchain based on Pandas, Numpy, and Matplotlib (or Plotly, or Seaborn). For small analyses, Jupyter notebooks are appropriate. Other data frameworks: ROOT (C++); Matlab, GNU Octave, and workalikes; Gnuplot; MS Excel and similar spreadsheets. For large (but not huge) datasets, SQL is a nice multi-backend language.
- Other tools in **the Python ecosystem**. For small web services, Bottle / Flask, parallelized by GUnicorn, including the Jinja templating language and appropriate tweaks to emitted HTML / CSS / Javascript. SQLAlchemy to abstract away database details. Literate in-line documentation and testing using Doctest, Pytest, Sphinx.
- In 2021 I built a small **realtime video-chat server**, which shared video from a proprietary augmented-reality (AR) headset with desktop/laptop users. The Python tools above spoke to a Janus WebRTC server, via a TURN relay. The AR interface was written in C# and Unity. Deployed to AWS, with appropriate management of SSL certificates and DNS names.
- **Computer programming, automation, and scripting**. Unix shells (sh / bash on Linux, MacOS, Cygwin, WSL) and POSIX utilities; Perl; Python. Emacs Lisp. Compiled tools in C / C++ / C#. Code revision control via Git or Subversion. Administration of small Unix / Linux server farms.
- **General laboratory / industrial skills** including vacuum systems; cryogenic systems; temperature monitoring and control; low- and high-voltage power distribution; designing, prototyping, and troubleshooting of analog and digital circuits; computerized data acquisition; radiological monitoring and shielding; lasers and optics; getting heavy, delicate objects from over here to over there; engineered and administrative safety systems.
- **Particle detectors and associated techniques**: Photodiodes / photomultipliers, bare or coupled to radiators or scintillators. Gas ion chambers. Semiconductor detectors. High-gain, high-speed amplification for single-particle counting; moderate-gain, low-noise amplification for continuous, high-precision measurements at high rates. Fast, modular digital logic (NIM / CAMAC / VME). Oscilloscope wizardry. Communication and control via Ethernet, RS232, etc.

Awards, Honors, and Affiliations

I am a member in good standing of

- Phi Beta Kappa
- Sigma Pi Sigma

I have previously been active in

- American Physical Society
- American Association of Physics Teachers
- American Association for the Advancement of Science

I am especially proud of the following:

2014–2017	Board of Directors, Barnard-Seyfert Astronomical Society
2007–2009	Research fellow, UT/ORNL Joint Institute for Neutron Science
2000–2003	Research fellow, UT/ORNL Science Alliance.
2001	Douglas V. Roseberry Award: Distinguished Upper Class Physics Major University Citation for Extraordinary Academic Achievement University Citation for Extraordinary Professional Promise
1997	Bicentennial Scholar
2014–present	Nashville Symphony Chorus
1993	Distinguished West Virginian

Este año (2022), mi proyecto de idioma es español.

Research experience

2009–2019 | **Measurement of the proton's "weak charge"**

The proton's familiar electric charge controls its coupling to the electromagnetic field and to the photon. In addition, the proton has a "weak charge" which governs its exchanges with the Z^0 boson, whose value is sensitive to unknown short-range forces. The Qweak collaboration has performed the first-ever measurement of this quantity by precisely measuring an asymmetry in the scattering of polarized electrons from hydrogen. I was responsible for the construction and operation of the Cherenkov electron detector array and was heavily involved in data collection and analysis.

Relevant publications: 1–4, 8–9

2003–2019 | **Weak neutral currents in proton-neutron capture**

The NPDGamma experiment has measured the parity-violating asymmetry in the distribution of photons from the capture of polarized neutrons on protons; this asymmetry probes the weak nucleon-nucleon interaction. I contributed to the construction and operation of the experiment at Los Alamos National Laboratory; to the analysis of the data obtained there; to the redesign and relocation of the experiment to Oak Ridge National Laboratory; and to the operation of the experiment's second run at Oak Ridge.

Relevant publications: dissertation; publications 5, 7, 10–18.

2003–2009 | **Neutron transport simulations**

Neutron beams are typically transported in guides, where neutrons propagate by lossy geometric optics. I performed and contributed to design simulations for proposed neutron beamlines at ORNL's High Flux Isotope Reactor and Spallation Neutron Source. I also performed measurements and accompanying simulations to characterize the installed neutron guides at Flight Path 12

at the Los Alamos Neutron Science Center and the Fundamental Neutron Physics Beamline at Oak Ridge.

Relevant publications: 6, 7, 16, 19–20.

2002–2005 | **Neutron beta decay experiments at SNS**

Beginning after 2015 the Spallation Neutron Source will house a spectrometer for measuring several angular correlations among the products of neutron beta decay; these correlations are sensitive to the relative strengths of the vector and axial vector weak couplings. I contributed to the preliminary design of the "abBA" spectrometer, including development for the combined electron-proton segmented detector and an implementation of an efficient algorithm for modeling charged particle transport in strong combined electric and magnetic fields.

Relevant publication: Desai et al. 2004

Selected publications

Sorted by publication date, new papers first.

1. D. Androić et al. (Qweak collaboration). "Determination of the ^{27}Al neutron distribution radius from a parity-violating electron scattering measurement." Physical Review Letters **128**, 132501 (2022). doi:10.1103/PhysRevLett.128.132501.
2. D. Androić et al. (Qweak collaboration). "Measurement of the beam-normal single-spin asymmetry for elastic electron scattering from ^{12}C and ^{27}Al." Physical Review C **104**, 014606 (2021). doi:10.1103/PhysRevC.104.014606.
3. D. Androić et al. (Qweak collaboration). "Precision measurement of the beam-normal single-spin asymmetry in forward-angle elastic electron-proton scattering." Physical Review Letters **125**, 112502 (2020). doi:10.1103/PhysRevLett.125.112502.
4. D. Androić et al. (Qweak collaboration). "Precision measurement of the weak charge of the proton." Nature **557**, 207–211 (2018). doi:10.1038/s41586-018-0096-0.
5. David Blyth et al. "First observation of P-odd γ asymmetry in polarized neutron capture on hydrogen." Physical Review Letters **121**, 242002 (2018). doi:10.1103/PhysRevLett.121.242002, arxiv:1807.10192.
6. K. B. Grammer et al. "New measurement of the scattering cross section of slow neutrons on liquid parahydrogen from neutron transmission." Physical Review B **91**, 180301(R) (2015). doi:10.1103/PhysRevB.91.180301, arxiv:1410.2177.
7. N. Fomin et al. "Fundamental Neutron Physics Beamline at the Spallation Neutron Source at ORNL." Nuclear Instruments and Methods A **773**, 45–51 (2015). doi:10.1016/j.nima.2014.10.042; arxiv:1408.0753.
8. T. Allison et al. (Qweak collaboration). "The Q_{weak} Experimental Apparatus." Nuclear Instruments and Methods A **781**, 105–133 (2015). doi:10.1016/j.nima.2015.01.023; arxiv:1409.7100.
9. D. Androić et al. (Qweak collaboration). "First Determination of the Weak Charge of the Proton." Physical Review Letters **111**, 141803 (2013). doi:10.1103/PhysRevLett.111.141803; arxiv:1307.5275.
10. M.T.W. Gericke, et al. "A measurement of the parity-violating gamma-ray asymmetry in the capture of polarized cold neutrons on protons." Physical Review C **83**, 015505 (2011). doi:10.1103/PhysRevC.83.015505.
11. L. Barrón-Palos, et al. "Determination of the parahydrogen fraction in a liquid hydrogen target using energy-dependent slow neutron transmission." Nuclear Instruments and Methods A **659**, 579-586 (2011). doi:10.1016/j.nima.2011.07.051.
12. S. Santra et al. "A liquid parahydrogen target for the measurement of a parity-violating gamma asymmetry in $\vec{n} + p \to d + \gamma$." Nuclear Instruments and Methods A **620**, 421–436 (2010). doi:10.1016/j.nima.2010.04.135.
13. M.T. Gericke et al. "Parity violation in neutron-proton capture: the NPDGamma experiment." Nuclear Instruments and Methods A **611**, 239–243 (2009). doi:10.1016/j.nima.2009.07.057.
14. P.N. Seo et al. "RF Spin Rotator for precision measurements of parity-violating gamma-ray asymmetry in radiative neutron capture with pulsed cold neutrons." Physical Review Special Topics: Accelerators and Beams **11**, 084701 (2008). doi:10.1103/PhysRevSTAB.11.084701; arxiv:0710.2871.
15. M.T. Gericke et al. "Upper bounds on parity-violating gamma-ray asymmetries in compound nuclei from polarized cold neutron capture." Physical Review C **74**, 065503 (2006). doi:10.1103/PhysRevC.74.065503; arxiv:nucl-ex/0608006.
16. P.N. Seo et al. "New pulsed cold neutron beamline for fundamental neutron physics at LANSCE." Journal of Research of NIST **110**, 145 (2004). doi:10.6028/jres.110.014.
17. S.A. Page et al. "Measurement of parity violation in np capture: the NPDGamma experiment." Journal of Research of NIST **110**, 195 (2004). doi:10.6028/jres.110.024.
18. M.T. Gericke et al. "Commissioning of the NPDGamma detector array: counting statistics in current mode operation and parity violation in the capture of cold neutrons of B_4C and ^{27}Al." Journal of Research of NIST **110**, 215 (2004). doi:10.6028/jres.110.027.
19. R. Mahurin et al. "Simulation of the performance of a fundamental neutron physics beamline at the High Flux Isotope Reactor." Journal of Research of NIST **110**, 157 (2004). doi:10.6028/jres.110.017.
20. P. R. Huffman et al. "Beamline performance simulations for the fundamental neutron physics beamline at the Spallation Neutron Source." Journal of Research of NIST **110**, 161 (2004). doi:10.6028/jres.110.018.
21. D. Desai et al. "Simulation of charged particle trajectories in the neutron decay correlation experiment abBA." Journal of Research of NIST **110**, 443 (2004). doi:10.6028/jres.110.068.
22. J. Avery, R. Mahurin, and G. Siopsis. "A brane in five-dimensional Minkowski space." arxiv:hep-th/0108132 (2001).

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